AGARISTIDÆ.

89. XANTHOSPILOPTERYX SUPERBA Butl.

Shiringoma and Makaya districts, November 1896.

NOCTUIDÆ.

90. TÆNIOPYGA SYLVINA Stoll.

Chiperoni, September 1896.

HYPSIDÆ.

91. EGYBOLIA VAILLANTINA Stoll.

Inure.

GEOMETRIDÆ.

92. COMIBÆNA LEUCOSPILATA Walk.

Portuguese East Africa (exact locality not noted).

3. On the Vascular System of the Chiroptera. By N. H. ALCOCK, B.A., M.D., Assistant to the Professor of Institutes of Medicine, Trinity College, Dublin[1].

PART I.—Thoracic Vessels of *Pteropus medius*; with a Summary of the Literature of the Chiroptera.

[Received October 13, 1897.]

The anatomy of the Chiroptera has been the subject of many and interesting researches. Dobson[2], in addition to numerous

[1] Communicated by Prof. G. B. HOWES, F.R.S., F.Z.S.

[2] DOBSON, G. E.—'Catalogue of the Chiroptera in the British Museum,' 567 pp., 30 pls.; London, 1878 (contains many references, chiefly to systematic papers). 'Monograph of the Asiatic Chiroptera' (includes European forms); London, 1876. "Secondary Sexual Characters in the Chiroptera," Proc. Zool. Soc. 1873, pp. 241–252. "On the Structure of the Pharynx, Larynx, and Hyoid Bones in the Genus *Epomophorus*," *loc. cit.* 1881, pp. 685–693. "Monograph of the Group *Molossi*," *loc. cit.* 1876, pp. 701–735. "Structure of Feet, Claws, and Wing-membrane of *Mystacina tuberculata*," *loc. cit.* 1876, pp. 486–488. "Monograph of the Genus *Taphozous*," *loc. cit.* 1875, pp. 546–556. "On Peculiar Structures in the Feet of certain Mammals, which enable them to walk on smooth perpendicular surfaces," *loc. cit.* 1876, pp. 526–535, pl. lv. (*Vesperugo*, *Mystacina*, *Thyroptera*, *Hyrax*). "On the Phalanx missing from certain Digits in the Manus of Chiroptera," Journ. Anat. Phys. xvi. p. 200. "Osteology of *Triænops persicus*," Journ. Asiatic Soc. Bengal, xli. pp. 136–142, pl. vi. "Chiroptera in Genoa Civic Museum etc.," Ann. Mus. Genov. (2) ii. pp. 16–19. "Report on Accessions to our Knowledge of the Chiroptera etc. in 1878–1880," Rep. British Assoc. 1880, pp. 169–197. "Geographical Distribution of Chiroptera," *loc. cit.* 1878, pp. 158–167. "Chiroptera in Göttingen Museum," Bull. Soc. Zool. France, 1880, pp. 232–239. "*Pteropus rodericensis*," Phil. Trans. clxviii. p. 457. "Conspectus of Sub-orders, Families, and Genera of Chiroptera, arranged according to their natural affinities," Ann. N. H. (4) xvi. pp. 345–357, and additional remarks, *loc. cit.* (4) xviii. pp. 345–347.

minor papers, has described the general anatomy of the Order, with a complete systematic arrangement of all the known genera and species, up to the year 1878. In more recent times Allen [1] has done the same for the North-American Bats. Macalister [2], in an able and comprehensive paper, has recorded the comparative anatomy of the muscles of the group; and Maisonneuve [3] has given a complete account of the myology and osteology of *Vespertilio murinus*. Robin [4] treats of the respiratory, digestive, and genito-urinary organs of the Order; and the embryological researches of Van Beneden and Julin [5] on the formation of the amnion here and in the Mammalia generally are well known. But with the exception of Röse [6], who, in his paper "Beiträge zur vergleichenden Anatomie des Herzens der Wirbelthiere," incidentally refers to the heart of *Pteropus poliocephalus* and *Vespertilio* (*Myotus*) *murinus*, and Hyrtl [7], who in 1864 described the arrangement of some of

[1] Allen, H.—"A Monograph of the Bats of N. America," Bull. U.S. Nat. Museum, No. 43, Washington, 1893, 193 pp., 37 pls. See also Washingt. Smiths. Inst. 1864, 8vo, 85 pp., woodcuts. Introduction to Monograph (1893), in P. U.S. Mus. xvi. pp. 1–28. "On the Molars of Pteropine Bats," Proc. Ac. Nat. Sci. Philadelphia, 1892, pp. 172–173. "Colour-marks in the Pteropodidæ," *loc. cit.* 1890, pp. 12–30. "Note on the Mammary Glands of Bats," *loc. cit.* 1880, p. 133. "Note on the number of the Phalanges of Bats," *loc. cit.* 1880, p. 359. "On the Temporal and Masseter Muscles of Mammals," *loc. cit.* 1880, pp. 226–228. "On the Embryos of Bats," Contrib. Zool. Lab. Pennsylvania, i. Art. 2, pls. v.–viii. "On a Revision of the Ethmoid Bone in the Mammalia, with special reference to the description of this bone and of the sense of smell in the Chiroptera," Bull. Mus. Comp. Zool. Harvard, x. p. 135, and an earlier paper, *loc. cit.* No. 5, pp. 121–122. "On the Tarsus of Bats," Am. Nat. xx. pp. 175–177. "Genus *Nyctinomus*," P. Am. Phil. Soc. xxvi. pp. 558–563. "Muscles of the Hind Limbs of *Cheiromeles torquatus*," Science, vii. p. 506.

[2] Macalister, A.—"The Myology of the Chiroptera," Phil. Trans. Roy. Soc. 1872, pp. 125–171, pls. 13–16.

[3] Maisonneuve.—Thèses présentées à la Faculté des Sciences de Poitiers. Paris, 1878, 8vo, pp. 324.

[4] Robin, H. A.—"Recherches anatomiques sur les Mammifères de l'Ordre des Chiroptères," Ann. Sci. Nat. (6) xii. 1881, Art. 2, pp. 111–180, pls. ii.–ix., & Rev. Sci. xxix. p. 507. See also "Sur la Morphologie les enveloppes fœtales des Chiroptères," Compt. Rend. xcii. pp. 1354–1357, and "Sur les envel. fœt. des Chiroptères d. l. famille des Phyllostomides," *loc. cit.* xcv. p. 1377, and "Sur les envel. fœt..... des Molossiens," supplementary to the second paper, Bull. Soc. Philomathique, Paris, (7) v. pp. 142–143. "Sur l'époque de l'accouplement des Chauves-souris," *loc. cit.* (7) v. pp. 88–90. "Anatomy of *Cynonycteris amplexicaudata*," C. R. xc. pp. 1369–1370.

[5] Beneden, E. Van, and Julin, C.—"Recherches sur la formation des annexes fœtales chez les Mammifères (Lapin et Chéiroptères)," Arch. Biol. v. p. 369, pls. Also "Observations sur le maturation, la fécondation, et la segmentation de l'œuf chez les Chéiroptères," Arch. Biol. i. pp. 551–571, pls. xxii. & xxiii., and Bull. Acad. Roy. Belgique, xlix. pp. 628–655.—E. Van Beneden. "De la Fixation du Blastocyste à la Muqueuse utérine chez le Murin (*Vespertilio murinus*)," *loc. cit.* (3) xv. pp. 17–27. "De la formation et de la constitution du Placenta chez le Murin," *loc. cit.* pp. 351–364.

[6] Röse, C.—"Beiträge zur vergl." etc., Morph. Jahrb. 1890, xvi. pp. 27–96, pls. iv. & v.

[7] Hyrtl.—Denksch. Akad. der Wiss. Wien, 1864, xxii. p. 132 *et seq.*, and a note on the Radial Artery, transl. by E. P. Wright, in Nat. Hist. Rev. vol. ii. 1862, p. 95 *et seq.*

the arteries in several species, the vascular system has received but scant notice.

The recent observations on the morphology of blood-vessels, especially those of Macalister[1], Mackay[2], Hochstetter[3], and, Young[4], have given an increased interest to studies of the vascular system; and it was in the hope of adding to the sum of our knowledge in this direction, even if only in a single order of the Mammalia, that this paper was commenced.

In the absence of any record of the general features of the Vascular System in the Chiroptera, the simplest plan appeared to be to describe as accurately as possible the arrangement in one species, taking it as a type to which variations might be referred, and this plan has been more or less adhered to in the following account. Illustrations have been added from other species where it appeared that the arrangement in *Pteropus medius* was unusual in the order, and some additional notes on the thoracic organs have been appended, when this seemed desirable for the sake of greater clearness in description.

The division of the Megachiroptera (Dobson) was selected on account of the greater size of its members, and *Pteropus medius*, the Indian Fruit-Bat, seemed a suitable representative[5]. This Bat is common in its native haunts—India—where it is found in large flocks, which often cause much loss by devouring enormous quantities of fruit, the voracity of these animals being apparently only limited by the amount of time and fruit at their disposal[6].

[1] Macalister, A.—"The Morphology of the Arterial System in Man," Journ. Anat. xx. 1886, pp.

[2] Mackay, J. Y.—"The Development of the Branchial Arches in Birds, etc." Phil. Trans. Roy. Soc. vol. 179 (1888), B. pp. 111–139, 4 pls. "The Arterial System of Vertebrates Homologically considered," Proc. Phil. Soc. Glasgow, xviii. 1887, and in Mem. of Anatom. vol. i. 1889.

[3] Hochstetter, F.—"Ueber d. ursprüngl. Hauptschlagader d. hint. Gliedm. d. Menschen," etc., Morph. Jahrb. xvi. 1890, pp. 300–318, and "Ueber d. Entw. d. Art. Vert. b. Kaninchen," *loc. cit.* pp. 572–586, and "Ueber den Ursprung der Art. Subclav. der Vögel," *loc. cit.* pp. 484–493.

[4] Young, A. H.—"The Termination of the Mammalian Aorta." Studies in Anatomy. The Owens Coll. 1891, pp. 209–225, 1 pl., & Journ. Anat. xxxi. pp. 169–175.

[5] The dissection of the smaller vessels in *Pteropus medius* proved difficult and tedious, although the body of this species is 8½ inches long and the expanded wings measure 3 feet across. The injection I found most suitable is the Lead Chromate and Gelatine recommended by Hoyer (Arch. f. mikr. Anat. 1876, p. 645), and quoted by Bolles Lee (Microtomist's Vade Mecum, p. 237), or Hoyer's Shellac injection, coloured with very finely divided vermilion (*loc. cit.* 1865, p. 149). I have found Von Graefe's cataract knife, modified by being strengthened a little along the back and shortened in the blade, very convenient. Some form of dissecting microscope is essential.

[6] Murray, J. A., Indian Annals, i. pp. 25–26, gives a description of this species, and an account of the use of the flesh as medicine by the natives. See also Sigel, W. L., Zool. Gart. xxiv. (habits of *P. medius* in captivity); and Day, F., Land of the Permauls, p. 439, who states that these Bats are very partial to wild figs and almond-kernels, and also to cocoa-nut toddy.

Beauregard, H.—"Recherches sur l'oreille interne de la Roussette de l'Inde (*P. medius*)," C. R. Ac. Sci. cxix. pp. 1351–1352. "Le Canal Carotid de Roussettes," C. R. Biol. Paris, 1892, pp. 914–916. "Recherches sur l'appareil

The average measurements of this species are given in Dobson's Catalogue. Two of my specimens measured:—Specimen A. *Adult male.* Length, *circa* 210 mm.; interfemoral membrane 10; head 72; ear 38; eye to tip of nostril 29; forearm 147; thumb 64·5; 3rd finger 183; tibia 65; foot 51.

Specimen B. *Adult male.* Length, *circa* 225 mm.; interfemoral membrane 15; head 72; ear 38; eye to tip of nostril 29; forearm 155; thumb 65·5; 3rd finger 292; 5th finger 205; tibia 71; foot 49. Weight, $10\frac{1}{2}$ oz. (spirit-specimen).

Thoracic Viscera.

The thorax in the Chiroptera is very much wider and more capacious than is usual in the Mammalia. *Pteropus medius* departs somewhat from the type, the thorax becoming longer and narrower, but still remaining very large. The thoracic viscera are correspondingly formed. The heart in this species is rather larger, and the lungs smaller, than is usual in the Order.

The Pleura.

Composed, as is usual, of a parietal portion, lining the thoracic cavity, and a visceral, clothing the surface of the lungs. But a certain degree of complexity is associated with the reflexion of this membrane from the upper aspect of the sternum, owing to the shape and disposition of the lungs and the relation to it of the so-called thymus gland.

Both parietal pleuræ pass upward together from the dorsal aspect of the sternum. Tracing first the pleura of the left side, anteriorly it passes upwards and to the left, and continued on the wall of the thorax is reflected on the anterior[1] surface of the pulmonary root, as in man. But owing to the projection across the mesial plane of the upper lobe of the left lung, the left pleural sac is carried to the right for a corresponding distance. On the ventral aspect is situated a portion of the thymus gland; a small tongue of the same gland extends forwards on its dorsal surface.

Posteriorly, the pleura passes to the left, lying ventral to the main part of the thymus and the pericardium, and then upwards, the line of reflexion from the diaphragm being 11 mm. to the left of the middle line. From this portion of the pleura the

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auditif chez les Mammifères," Journ. de l'Anat. et Physiol. 1893, pp. 180–220, pls. iv.–vi.

Home, Sir Everard.—Lectures on Comparative Anatomy. London, 1814, vol. i. pp. 158–160, vol. ii. pl. xx. (stomach of *Pteropus* and *Plecotus*).

Cattaneo, G.—"Sull' Anatomia dello Stomaco del *Pteropus medius*," Atti Soc. Ligustica, i. pp. 142–149.—Wunderlich, L., "Die Fortpflanzung der Flughunde (*Cynonycteris collaris*, Ill., and *P. medius*, Temm.) im Zool. Gart. zu Köln," Zool. Gart. xxxii. pp. 78–82.

[1] These terms suppose the animal to be placed with the ventral surface downwards, "above" being therefore synonymous with "dorsal to"; "anterior" and "in front of" corresponding to "on the cephalic side of."

ligamentum latum pulmonis proceeds outwards to the posterior lobe of the left lung, very much as in man.

The pleura of the right side extends upward from the sternum until it reaches the pericardium. Anteriorly it is folded around this, and reaching the root of the right lung becomes continuous with the visceral layer. Posteriorly, this reflexion of pleura passes upwards until it reaches the postcaval vein, which has an intra-thoracic course of some length—7 mm. in this species. Turning round the vein the pleura retraces its course, forming thus a median recess or pouch, in the posterior part of which lies the azygos lobe of the right lung, the anterior part being reduced to a mere chink by the near approach of the pericardium towards the diaphragm [1]. The pleura finally leaves the anterior thoracic wall in company with the pleura of the left side, considerably to the left of the mesial plane. The *ligamentum latum pulmonis* passes to the posterior lobe of the right lung from the reflexion of pleura thus formed, lying dorsal to the azygos lobe.

The Lungs.

Following the nomenclature of Aeby [2], four lobes may be distinguished in the right lung—anterior, middle, posterior, and azygos; and two in the left—anterior and posterior. This agrees with the description of Robin [3], whose careful and accurate work leaves little to be added by subsequent investigators.

The right lung is considerably larger than the left, and the main lobes of each are much subdivided by secondary fissures. The morphology of these, as well as an account of the pulmonary arterial and venous system, will be found in Part II. of this paper.

The relation of the lungs to the ventral wall of the thorax would appear to vary somewhat. Robin [3] describes the posterior lobe of the left lung as extending across to meet the middle lobe of the right lung, lying beneath the base of the heart and great vessels. In my specimens, shrunk a little by immersion in spirit, this was not the case (fig. 1), and in transverse sections of *Vesperugo noctula* and *Rhinolophus hipposideros*, with the organs carefully hardened *in situ*, there was still a considerable interval.

The anterior lobe of the left lung crosses the mesial plane ventral

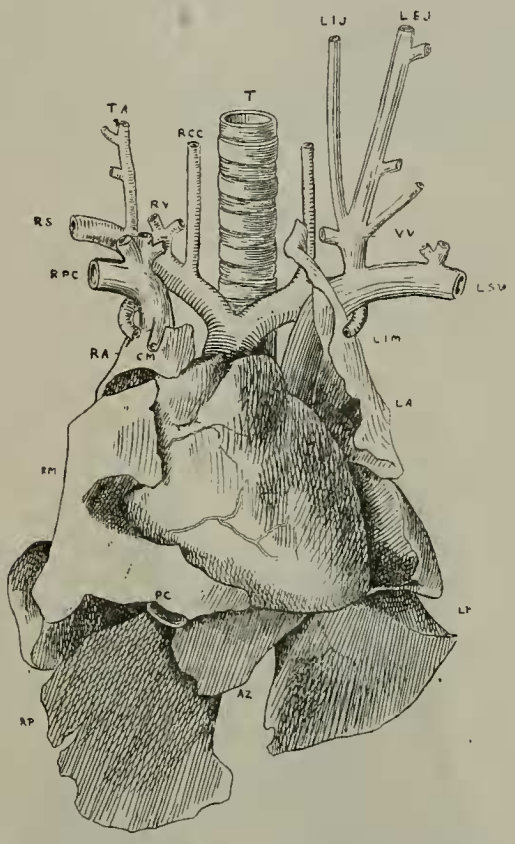
[1] I was interested in observing in a dissection of a Dromedary an intermediate stage between the condition found in *Pteropus* and in man. In that animal, anteriorly the pleuræ of both sides pass upward in the middle line from the sternum, forming a definite mesial partition. Posteriorly, the arrangement is exactly similar to that described above, except that the median recess is much reduced in size, owing to the smaller development of the azygos lobe. The pleura is strong and tough, and can be followed out with the greatest ease. In man, the azygos lobe has altogether disappeared in the adult, and the pleural recess is reduced to a minimum ("*mediastino-diaphragmatic sinus*," Macalister, Human Anatomy: London, 1889, p. 316).

[2] Aeby.—Der Bronchialbaum der Säugethiere, etc. Leipzig, 1880.

[3] Robin, H. A.—"Recherches etc." *v. supra.* See also on this subject, Daubenton (Buffon and Daubenton, Hist. Nat. x. p. 70, 1763). Owen (Comp. Anat. of Vertebr. iii. p. 577), and Cuvier (Anat. Comp. 2nd ed. vii. p. 151).

to the pericardium, and the azygos lobe of the right lung crosses similarly on the dorsal side, lying immediately behind the left auricle and ventricle.

Fig. 1.



Heart and lungs of *Pteropus medius*, seen from the ventral aspect. $\times 1\frac{1}{2}$. The blood-vessels are slightly diagrammatic; the exact position is seen in fig. 4 (p. 66), which is from a photograph. The anterior lobe of the left lung is raised slightly to show the conus arteriosus.

R.S. Right Subclavian artery. T.A. Thyroid Axis. R.C.C. Right Common Carotid. R.V. Vertebral. L.I.M. Left Internal Mammary. R.P.C. Right Precaval Vein. L.S.V. Left Subclavian Vein. L.I.J. Left Internal Jugular. L.E.J. Left External Jugular. V.V. Left Vertebral. P.C. is placed on the middle lobe of the right lung just above the Postcaval Vein. T. Trachea. RA., RM., RP. Anterior, middle, and posterior lobes of the right lung. AZ. Azygos lobe. LA., LP. Anterior and posterior lobes of the left lung.

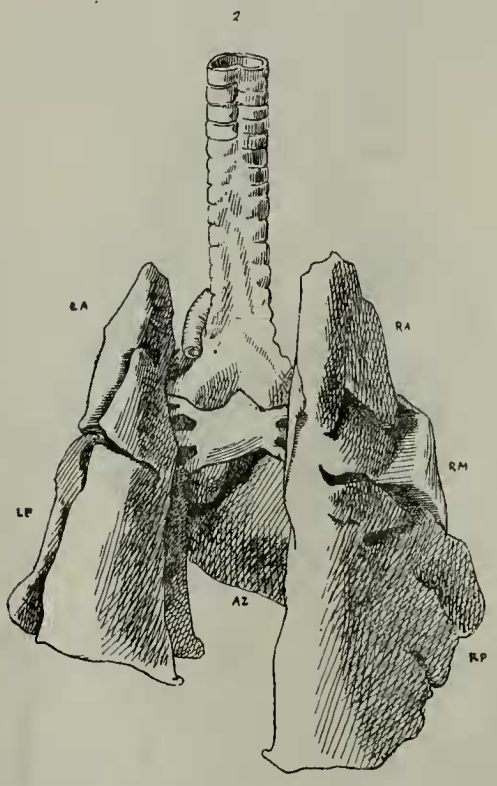
The Pericardium.

A very definite sac, composed of two layers—a fibro-serous, forming an envelope for the heart and great vessels, and a serous, reflected on to the surface of those structures.

The fibro-serous layer encloses a space, the shape of which is

approximately oval in outline. It is prolonged forward to become continuous with the outer coats of both precaval veins and the aorta, and encloses within it the whole length of the pulmonary artery. Behind, it is pierced close to the auricle by the postcaval vein, so that this vessel has only a course 3 mm. in length within the pericardium, in spite of the length of the intra-thoracic portion of that vessel. Posteriorly, this layer is in contact with the diaphragm, but the connexion between them is of the slightest, the most definite attachments being by means of the reflexion of the pleura from the diaphragm on each side.

Fig. 2.



Heart and lungs of *Pteropus medius*, dorsal aspect. $\times 1\frac{1}{2}$.
Letters as in fig. 1.

Intimately connected with the fibro-serous layer of the pericardium is the so-called thymus gland, especially on the ventral surface. Elsewhere this layer is thin and delicate, resembling the human peritoneum in appearance, but firmer and less elastic than that structure.

The serous layer clothes the surface of the heart; it is reflected from the outer layer where the postcaval vein enters, as well as at the entrance of the other vessels.

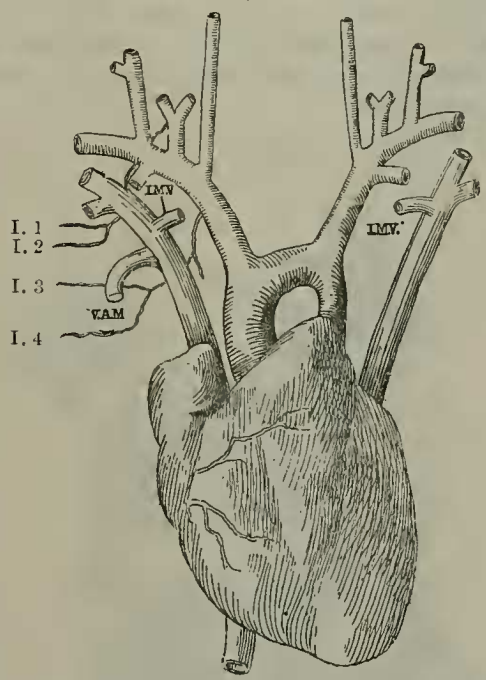
Thymus[1].

The general collection of tissue that has in the aggregate been called the thymus gland is developed to an unusual extent in the Chiroptera. In this species it is composed of gland-like masses irregular in outline, showing a tendency to separate into smaller lobules. This tissue is scattered about the middle mediastinum, one mass being placed at the base of the heart, another ventral to the pericardium where it meets the diaphragm, another within the pericardial sac, at the base of the great vessels. The relation of the gland to the pleura is very intimate.

The Heart.

Of large size even for the Chiroptera, measuring 26 × 15 × 15 mm. The general shape is that of an elongated oval, placed very obliquely

Fig. 3.



Heart of *Pteropus edulis*, ventral surface, ×1½.—I. 1-4. Intercostal arteries in the upper four spaces of the right side, 1 and 2 arising from the Vertebral, 3 and 4 from the Innominate. I.M.V. Internal Mammary Veins, joining the Right and Left Precaval veins. V.A.M. Vena azygos major.

[1] The description applies to the naked-eye appearance of this structure. Microscopic sections (specimen A) show numerous much vacuolated cells, with no definite arrangement, intimately related to blood-capillaries, and with no ducts. Sections of the same gland in specimens C and D show only adipose tissue. Further investigation is necessary to reconcile the appearances observed.

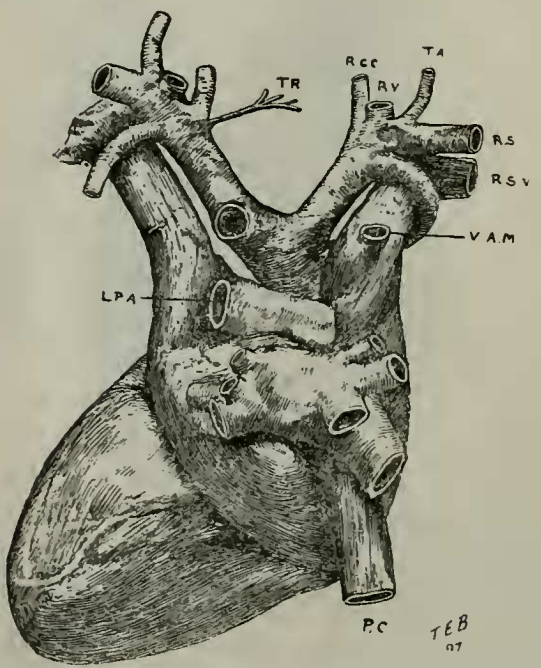
in the thorax, the apex extending posteriorly and to the left. Clothing the surface is the serous layer of the pericardium; and it is noticeable that the deposit of fat, so often observed in man, is entirely absent here. In the groove between the right auricle and the aorta is a small portion of the so-called thymus gland.

Fully three-fourths of the ventral surface is formed by the ventricles, little more of the right auricle than the appendix being seen from this aspect, and but the extreme tip of the appendix of the left auricle, appearing under cover of the left precaval vein. Of the ventricular part, three-fifths are formed by the right ventricle, the remainder, including the apex, by the left. (Fig. 1, p. 63.)

On the dorsal surface of the heart the ventricles occupy scarcely one half, the auricles, with the much expanded transverse part of the left precaval vein, forming the remainder. (Fig. 4.)

The *Right Auricle* is composed of appendix and atrium, separated externally by a well-marked sulcus. In the specimens I have examined it was much distended with clotted blood, so that it appeared considerably more capacious than the left auricle. More of the right auricle also appears on the surface than the left, the latter being concealed by the left precaval vein and the pulmonary artery with its branches.

Fig. 4.



Heart of *Pteropus medius*, dorsal surface, ×2.—TR. Pretracheal branch from base of left common carotid artery. L.P.A. Left Pulmonary Artery. Other letters as in fig. 1.

The wall of the right auricle is thin, and on opening the cavity

is seen to be sculptured in low relief over the greater part of its extent with a series of muscular bands running parallel to each other at a little distance apart, joined with cross bands and terminating on a well-marked crista terminalis. These musculi pectinati are stouter and better marked in the appendix than elsewhere. There was no representative of the "tubercle of Lower."

Three main venous trunks open into the atrium. The aperture of the right precaval vein is the most anterior; at some little distance behind is the opening of the postcaval, guarded by the Eustachian valve, here a thin fenestrated membrane, continued on to the isthmus Vieussenii as in man. (Fig. 6, p. 68.) Just above the auriculo-ventricular opening is the entrance of the left precaval vein, separated from the postcaval by a well-marked muscular shelf, the valve of Thebesius being entirely absent, as Röse [1] also found. Two or three ventral cardiac veins run forward over the right ventricle to open directly into the auricle, and two or three dorsal veins, one larger than the rest, open into the transverse part of the left precaval.

The *Right Ventricle* is folded around the left ventricle, and the interventricular septum encroaches on its cavity, so that the outline in transverse section is crescentic.

The conus arteriosus is markedly prolonged, forming a very characteristic feature in the Chiropteran heart, and even more conspicuous in *Pteropus edulis* (fig. 3, p. 65) than in this species.

The inner surface of the ventricular wall is quite smooth and uniform except where it meets the septum, where a few very small irregularities remain. No musculi papillares arise from the ventricular wall; a very slender moderator band alone takes origin here and passes to the septum.

The auriculo-ventricular valve has developed on a somewhat different plan from most other Mammalia, resembling the condition figured by Ray Lankester [2] in the Rabbit. It is composed of two separate segments, the outermost and ventral of these being considerably the larger, representing the infundibular and marginal parts of the usual tricuspid valve. Arising from the interventricular septum to supply this segment are four musculi papillares, each sending 3–4 chordæ tendineæ to be inserted into the free edge of the valve, the adjacent chordæ being continued upward on the outer surface to form an arch [3], as shown in fig. 5, p. 68.

The innermost segment is closely applied to the septum. Many

[1] Röse, C., *loc. cit.*

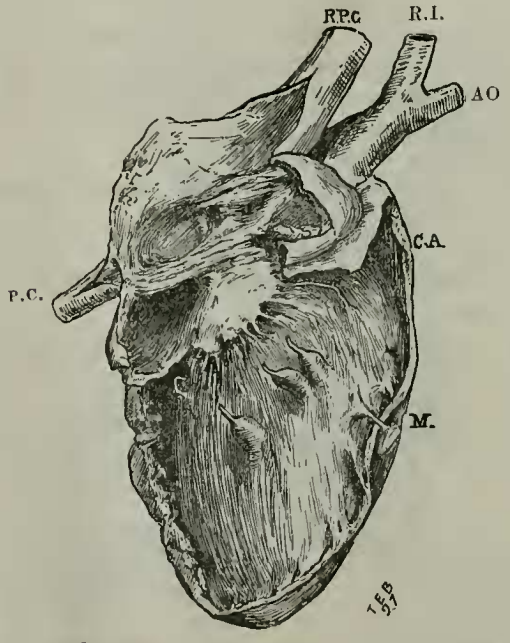
[2] P. Z. S. 1882, pp. 535–544, pl. xxxviii. figs. 3 and 4. He considers the auriculo-ventricular valve in this animal to be a further development from the original condition preserved in man and most mammals. If this view be adopted, the valve in *Pteropus* might be considered to occupy an intermediate condition. On the origin of the musculi papillares from the septum, see Röse (*loc. cit.* pp. 84–85), who remarks that it is a point of no morphological importance.

[3] Kürschner (Wagner's Handwörterbuch, p. 47) describes a similar arrangement of chordæ tendineæ in the human heart as an uncommon abnormality. Class 1 of his division is unrepresented in the heart of *Pteropus*.

Fig. 5.

Heart of *Pteropus edulis*, ×2.—A portion of the wall of the right ventricle has been turned back to show the auriculo-ventricular valve, the two segments of which are seen. M. Moderator band.

Fig. 6.



Heart of *Pteropus edulis*, ×2.—The right auricle has been opened by the usual incisions, and the whole of the wall of the right ventricle removed with the outer segment of the auriculo-ventricular valve; the septal segment is seen in its whole extent. AO. Aorta. R.I. Right Innominate Artery. R.P.C. Right Precaval Vein. P.C. Postcaval Vein; below this is seen the opening of the Left Precaval. C.A. Conus arteriosus. The attachments of the musculi papillares and moderator band to the septum are shown.

slender chordæ tendineæ are attached to its free edge; they all arise directly from the septum, without the intervention of musculi papillares, and they are quite separate from the set belonging to the outer segment, each set supplying its own part of the valve only (fig. 6, p. 68).

The pulmonary orifice is guarded by a valve of three semilunar flaps, two placed ventrally and one dorsally, as in man.

The atrium of the *Left Auricle* appears on the dorsal surface of the heart between the systemic veins entering the right auricle and the pulmonary artery. (Fig. 4, p. 66.) The tip of the appendix appears on the ventral surface, the base being concealed in front by the right pulmonary artery and on the left by the left precaval vein. On opening the cavity, the walls are seen to be thicker than those of the right auricle, and smooth internally, a few feeble musculi pectinati being found only in the appendix, which is longer and narrower than on the right side and much less capacious. On the interauricular septum a faint depression indicates the position of the foramen ovale; here the wall is very thin, but no communication exists between the auricles.

The left pulmonary veins open by one common orifice into the dorsal surface of the atrium, the right by three separate openings.

The *Left Ventricle* contrasts markedly with the corresponding cavity on the right side, being constructed on a much stronger and more muscular plan. The outline in transverse section is circular. Two large and strong papillary muscles, extending down to the apex, and attached along their whole length to the outer portion of the ventricular wall, send chordæ tendineæ to the two segments of the mitral valve, each papillary muscle supplying part of both segments. Fine columnæ carneæ, consisting of low closely-set ridges, cover the interventricular septum and the wall of the ventricle between the muscular attachments.

The auriculo-ventricular aperture is oval in shape, and considerably smaller than on the right side. The mitral valve consists of two segments—the lesser is placed against the outer wall of the ventricle, the greater hangs between the aortic and auriculo-ventricular orifices. The aortic valve consists of three segments, one ventral and two dorsal, and the coronary arteries arise from the ventral and left dorsal sinuses of Valsalva. The structure of both this and the pulmonary valve closely resembles the arrangement in man.

The weight[1] of the heart in *P. medius* is about 26 grains, approximately $\frac{1}{176}$ of the body weight, compared with $\frac{1}{205}$ in man. The thickness of the wall of the right ventricle at its base is 1 mm., of the corresponding part of the left ventricular wall 4 mm. This ratio is even greater in the smaller Bats, in *Vesperugo noctula*, for instance, the figures are ·5 mm. and 2·4 mm.

The Aorta and its Branches.

Arising from the left ventricle, the ascending aorta is at first concealed from view in the undissected heart. The right auricular

[1] Taken from spirit-specimens.

appendix and the infundibulum of the right ventricle cover it on the ventral aspect. The right auricle and the right precaval vein conceal it on one side, the pulmonary artery on the other, and on the dorsal surface the right pulmonary artery crosses above it. A comparatively short distance remains therefore between the surface of the heart and the origin of the right innominate artery (fig. 1). This vessel arises at a distance [1] of 8·5 mm. from the ventricle, and from this point the aorta, reduced in diameter from 4 mm. to 3 mm., crosses the thorax, curving round the trachea. The left innominate artery takes origin 6 mm. from the right innominate, and from this point the course of the aorta is upward and backward, receiving the obliterated ductus arteriosus 4·5 mm. from the left innominate, and passing above the root of the left lung.

The left vagus nerve crosses between the left innominate and left precaval vein, the recurrent laryngeal branch turning round the ductus arteriosus. The trunk of the nerve passes on to form anterior and posterior pulmonary plexuses in the usual manner.

The descending thoracic aorta has much the same relation to surrounding structures as in man, lying on the bodies of the vertebræ between the pleural sacs, and having the thoracic duct and vena azygos major to the right, while the œsophagus lies on its ventral surface. The length from the ductus arteriosus to the opening in the diaphragm is 35 mm.

The descending thoracic aorta gives off the usual œsophageal and mediastinal branches, and intercostal arteries to all the spaces below the second. The first space is supplied by a branch from the vertebral, the second space either from the vertebral or, more commonly, from the aorta. The anterior intercostal arteries on the right side pass outwards dorsal to the thoracic duct and vena azygos major, below the eighth space they cross on the ventral side. The relations of the sympathetic cord and subcostal muscle are similar to man.

In one specimen of *Pteropus edulis* the upper two spaces on the right side were supplied by the vertebral, the third and fourth by a branch from the innominate (fig. 3, p. 65), the remainder from the aorta. The bronchial arteries in this species arose by a single trunk from the aorta.

Right Innominate Artery.—With the exceptions to be presently noted, the right and left innominate arteries correspond closely with regard to their course, distribution, and branches. Springing from the right extremity of the aortic arch the artery of the right side, 2 mm. in diameter, passes forward and outward, and above (dorsal to) the sterno-clavicular articulation, at a distance of 6 mm. from its origin, divides into the right common carotid and subclavian, the former, much the smaller, appearing like a branch of the main trunk.

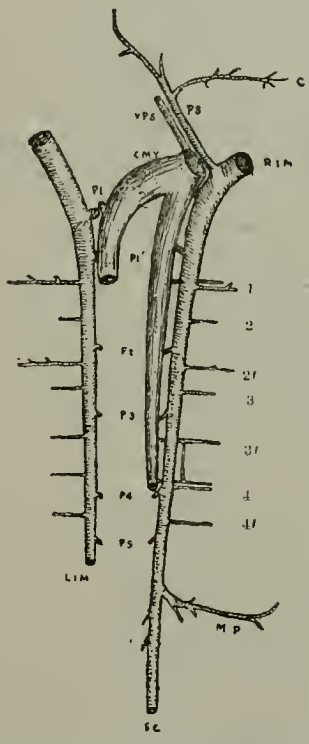
Small mediastinal branches arise from both innominate arteries to supply adjacent structures.

[1] The measurements of arteries and veins are all taken to the mid-point of the origin of the branch referred to, except when otherwise indicated.

The *Common Carotid Artery* on either side runs directly forward, the only thoracic branch being a small offset to the front of the trachea, springing from the artery of the left side close to its origin from the innominate.

The first branch of the *Right Subclavian Artery*, which here appears like the continuation of the innominate, is the internal mammary, arising from the outer side of the vessel scarcely 1 mm. from the origin of the common carotid. 15 mm. beyond this, from the opposite side of the subclavian, is the origin of the vertebral. This vessel, nearly equal in size to the remainder of the parent trunk, has a short course directly forwards, and then divides into two branches, one running outwards, the other, the vertebral proper, entering the vertebrarterial canal of the sixth cervical vertebra.

Fig. 7.



The Internal Mammary Arteries and Veins from the dorsal aspect, $\times 1\frac{1}{2}$.—R.I.M. & L.I.M. Right and Left Internal Mammary Arteries. PS. Presternal Artery. C. Clavicular branch. 1. Ventral Intercostal Artery in first intercostal space; 2, 2′, in second space; between 1 and 2 lies the second rib, similarly for the rest of the series. 3′ is absent on the right side. M.P. Musculo-Phrenic Artery. S.E. Superior Epigastric Artery. P 1—P 5. Ventral perforating arteries in the several outer costal spaces. C.M.V. Common Mammary Vein, formed by union of the veins of both sides. V.PS. Presternal Vein. A communicating band joins the ventral intercostal veins of the third and fourth spaces on the right side. Except wehre drawn, the veins are exactly similar to the arteries in their distribution, one vein accompanying each artery.

1 mm. from the origin of the vertebral the thyroid axis, a slender vessel running forward, is given off, and from this the subclavian pursues a course almost directly outward, and arching across the first rib is continued into the axillary.

The two *Internal Mammary* arteries (figs. 1 and 7) differ somewhat on the two sides. The right internal mammary, rather larger than the left, arises from the subclavian, and turning round the right precaval vein runs at first obliquely inward and backward, between the pleura and the chest-wall, and embedded in the substance of the ventral part of the thymus gland. After a little the common mammary vein joins the artery, lying to its inner side. Reaching the junction of the presternum with the mesosternum, the artery passes backward, and finally divides opposite the sixth costal cartilage into the musculo-phrenic and superior epigastric arteries, the latter considerably the larger and continuing the direction of the parent trunk.

The branches of the internal mammary artery are :—

1. A branch arising 11 mm. from the subclavian, which runs forward and inward (fig. 7) to the suprasternal notch, where it divides into several branches to supply the upper part of the thymus, the trachea, the infrahyoid muscles, and the anterior part of the pleuræ, and sends one slender twig outward along the anterior border of the clavicle. This branch I have called *presternal*.

2. Ventral perforating arteries, which supply the pectoralis major and adjacent muscles. In the first intercostal space one perforating artery appears at the upper part of the space and one at the lower ; all the subsequent spaces have only one each, appearing at the lower border of the space. In this species all these arteries do not differ much in size, but in many of the Microchiroptera (*V. noctula* e. g.) the first and fourth (third space) are much larger than the rest.

3. Ventral intercostal branches. Two in each space except the 1st, arising separately from the internal mammary, and with a course as in man along the margins of the ribs. The branch at the posterior edge of each space is a very minute vessel.

I could not discern any branch corresponding to the arteria comes nervi phrenici of human anatomy.

The Left Internal Mammary Artery has a similar origin to the right. It turns round the left precaval vein, and passes to a similar position by the side of the mesosternum, giving off no branches until it reaches this point. Here it first meets with the left internal mammary vein, which lies internal to it, and for the rest of its course resembles exactly the artery of the right side.

Thoracic Veins.

Right Precaval.—In the lower part of the neck three venous trunks join—the vertebral, the internal jugular, and the external jugular, the two former nearly equal in size, the latter as large as both taken together (fig. 1). After a course of 2·5 mm. the common trunk thus formed joins with the subclavian, at a point immediately above the sterno-clavicular articulation, and

is continued onward as the precaval. Immediately dorsal to the vessel there is the right subclavian artery.

The precaval vein then runs inward and backward to join the anterior part of the right auricle. On its right side are placed the corresponding internal mammary artery, the upper lobe of the right lung, and the right phrenic nerve. To the left lie the right innominate artery, the ascending aorta, and posteriorly the left vagus nerve. On the ventral surface the precaval, below the entrance of the common mammary vein, is covered by the upper lobe of the right lung. Its total length is 10 mm.

The tributaries of the right precaval are :—

1. The vena azygos major, joining the dorsal surface of the vessel 4 mm. from the surface of the auricle.

2. The common mammary vein, joining the ventral surface.

3. Small mediastinal and thymic veins enter at various places.

The course of the *Vena Azygos Major* is forward, lying on the left side of the centra of the vertebræ, till it reaches the fourth intervertebral disc. Here it turns downward and ends by joining the right precaval, as already described. The intercostal veins of both sides join the vena azygos major (those of the left side passing above the aorta), except in the first intercostal space on the right side, and the first and second on the left, the veins from these spaces passing to the vertebral.

Common Mammary Vein.—The right and left internal mammary veins arise by tributaries which correspond closely to the arteries, one *vena comes* accompanying each branch. Both veins run forward, lying immediately behind the junction of the ribs with the mesosternum, immediately internal to the artery (fig. 7). At the middle of the first intercostal space, having been joined by the highest perforating vein, the left internal mammary inclines to the right, crossing behind the presternum, and joins the vein of the right side to form the common mammary [1]. This continues the direction of the left vein, and, receiving a tributary corresponding to the presternal artery, joins the right precaval, 6·5 mm. from the surface of the auricle.

In fig. 3 (p. 65), which represents the heart and great vessels of *Pteropus edulis*, the internal mammary veins are seen to join the corresponding presternal veins in the usual manner.

Left Precaval Vein.—Formed by the same tributaries and in the same manner as the corresponding trunk on the right side. The vessel lies at first between the subclavian artery above and the upper lobe of the left lung below, pursuing a slightly arched course backward and a little inward, till it reaches the auriculo-ventricular groove, 19 mm. from its origin. Here it turns to the right, and much increased in calibre ends in the right auricle, at a point corresponding to the opening of the coronary sinus in man.

The left precaval vein receives small mediastinal and thymic branches, and close to its termination the dorsal cardiac veins.

Postcaval Vein.—The thoracic portion of this vessel runs directly

[1] A very similar arrangement is to be met with in the Capybara (*Hydrochærus capybara*) and also in the Common Fox (*Canis vulpes*).

forward, receiving no tributaries, to the right auricle. The vein lies in a groove in the azygos lobe of the right lung, separating it from the posterior lobe; its relation to the pleura has been already noticed. This part of the vessel measures 7 mm. in length.

I have been obliged, owing to ill-health and other causes, to postpone the publication of the rest of this paper.

I have much pleasure in expressing my thanks to Professor Howes, for his kindness in providing me with material; to Mr. W. C. Hoyle, for great assistance in consulting the literature of the Order; and to Miss E. M. Gore, for some beautifully executed drawings.

Literature.

The systematic and distributional literature of the Chiroptera is tolerably voluminous. It is unnecessary in this paper to do more than briefly refer to the labours of O. Thomas, F. A. Jentink, and others, published chiefly in the 'Annals and Magazine of Natural History,' 'Annali del Museo di Genova,' and 'Proceedings' of this Society. Up to 1878 many references are to be found in Dobson's Catalogue, and in more recent times in H. Allen's Monograph, and Flower and Lydekker's *Mammals* (Introduction to Study of Mammals etc., Lond. 1891. Chiroptera, pp. 641–679). Since 1864 a very complete list may be found in the Zoological Record for each year.

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February 15, 1898.

Dr. A. Günther, F.R.S., V.P., in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of January 1898:—

The total number of registered additions to the Society's Menagerie during the month of January was 64, of which 26 were by presentation, 33 by purchase, and 5 were received on deposit. The total number of departures during the same period, by death and removals, was 78.

The Secretary read the following extract from a letter addressed to him by Mr. D. Le Souëf, dated Melbourne, Nov. 27, 1897:—

"I some time ago had an embryo Kangaroo sent me, which I have photographed, and send on, in case it may be of interest to you. The Kangaroo was seen sitting under the shade of a tree, and had her head apparently in her pouch, which she seemed to be holding open with her fore-paws. She was shot dead and fell over. On examining her pouch the little embryo was found lying loose—the mother had apparently been putting it on to the teat with her lips when shot. The teat was much contracted at the end, which would enable the parent to fix the young one on to it. The Kangaroo was sitting on her tail, that member being stretched out in front of her—a favourite position of the Kangaroo family. She was probably in the same position when the young one was born,

and therefore it would not touch the ground, but immediately on birth could be at once transferred to the pouch"[1].

Mr. Arthur Thomson, the Society's Head Keeper, laid on the table a series of specimens of various Insects reared and exhibited in the Insect-house in the Society's Gardens during the past year and read the following report on the subject:—

Report on the Insect-house for 1897.

Examples of the following species of Insects have been exhibited in the Insect-house during the past season:—

Silk-producing Bombyces and their Allies.

Asiatic.

Attacus atlas.
—— *cynthia.*
—— *ricini.*
Attacus pernyi.
Antheræa mylitta.

American.

Samia cecropia.
—— *ceanothi.*
Actias luna.
Anisota stigma.
Telea polyphemus.
—— *promethea.*
Hypochiria io.
Eacles imperialis.

African.

Attacus mythimna.
Antheræa menippe.
—— *cytherea.*
Cynanisa isis.
**Imbrasia epimeathea.*
**Bunea phœdusa.*
Eudæmonia brachyura.
Lasiocampa monteiri.

Diurnal Lepidoptera.

European.

Papilio podalirius.
—— *machaon.*
Thais polyxena.
—— *cerisyi.*

American.

Papilio zolicaon.
—— *cresphontes.*
—— *asterias.*
Papilio turnus.
—— *ajax.*
Limenitis disippus.

Nocturnal Lepidoptera.

Sphinx ligustri.
—— *carolina.*
*—— *lucitiosa.*
Smerinthus ocellatus.
—— *excæcatus.*
*—— *myops.*
Ceratomia amyntor.
—— *undulosa.*
Deilephila euphorbiæ.
—— *galii.*
—— *elpenor.*
—— *porcellus.*

* Exhibited for the first time.

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[1] *Cf.* Pinkert, E., "Beobachtungen bei der Geburt eines Känguruh, *Macropus rufus*," Zool. Gart. xxx. p. 85.—Ed.

Of the Lepidopterous Insects which I have the honour to place before the meeting, *Sphinx lucitiosa* and *Smerinthus myops*, from North America, *Imbrasia epimeathea* and *Bunea phœdusa* from Sierra Leone, were exhibited for the first time in 1897.

During the past summer five specimens of the Goliath Beetle, *Goliathus druryi*, have been exhibited. They fed well upon bananas, but I am sorry to say they are all dead. The single male received I exhibit this evening.

One of the most interesting exhibits of the past summer and at the present time is a colony of the Parasol Ant (*Œcodoma cephalotes*). These ants were presented by Mr. F. W. Urich, and were brought to England from Trinidad, by Mr. R. R. Mole, C.M.Z.S., and were received on May 11, 1897.

I had a zinc tray made for the curious insects, with a moat round it, which was filled with water to prevent their escape. At one end of the tray I placed the package containing the ants on a little table, and at the other end a small growing rose-tree in a pot. The pot and the table were connected by means of a dead tree-branch. The ants soon found their way across this bridge and immediately set to work to close up the openings of the box in which they had travelled with the mould in which the rose-tree was growing. In a day or two the ants began to cut pieces out of the leaves of the rose-tree, and these they carried across the bridge, into what I might call their nest.

Towards the autumn the ants appeared to get tired of their quarters, and persistently carried the refuse from the nest and dropped it into the water, with the idea, I think, of bridging it over and thus getting across. I then put into the middle of the tray a pot of fresh mould, and cut the bridge into two pieces, but no notice was taken of this. The ants still kept throwing the refuse into the water, and would no doubt, if left alone, have soon made a way across the moat.

When rose-leaves were not obtainable, the ants were fed upon orange-peel, and carried into the nest the *inside* pith of the peel.

Of Spiders, examples of two very interesting species have been exhibited. The first received was a specimen of *Scodra calceata*, from West Africa, presented by Mr. F. W. Marshal on the 27th March, which died on the 12th Sept., 1897. The second was a very fine specimen of *Pœcilotheria striata* from India, presented by Mr. H. R. P. Carter on the 21st Oct. last. This fine Spider, I regret to say, only lived two days in the Gardens. An interesting account of this Spider will be found in the 'Field' of Oct. 30, 1897 (vol. xc. p. 705).

The Secretary exhibited a series of Lepidopterous Insects prepared and set by Mr. S. W. Denton, of Wellesley, Mass., U.S.A., in illustration of the system adopted in 'Denton's Patent Butterfly Tablets,' as well adapted for public museums where close examination was not required.
